Horse Barn Ventilation

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Factsheet

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Animal health is very important to horse owners, and good air quality is essential for minimizing respiratory health problems. Good air quality starts with a good ventilation system that also helps protect the horse barn structure from moisture damage by reducing condensation.

WHAT IS GOOD AIR QUALITY FOR HORSES?

Horses are more comfortable in well-ventilated barns with good barn air temperature and humidity, and few air contaminants and drafts.

Barn air temperature is affected by the season, and the species, age and weight of the horses. Temperatures ranging from 10°C to 24°C can be considered optimum; avoiding sudden changes in air temperature is often more important than the actual temperature.

Barn air humidity is also important. Very dry air (low relative humidity) dries the horse's nasal mucosa and can be a source of dust and pathogen infiltration into the horse's respiratory system. Very moist air (high relative humidity) combined with low air temperatures can reduce the insulation properties of the horse's hair coat. Very moist air combined with high air temperatures can create moisture build-up and dripping on the surfaces of building materials inside the horse, which can cause premature deterioration. Relative humidity in horse barns should be in the range of 60%–70%.

Dust, pathogens and gases from feeding, bedding, manure and the horses themselves affect air quality. Dust particles in the air can affect respiratory organs and transmit pathogens. Gases such as ammonia (NH_3) and hydrogen sulphide (H_2S) form acids that burn respiratory tissues. A well-ventilated horse barn should not have high levels of moisture or gases.

Just like people, horses do not want to be housed in a drafty area. Air velocity may create discomfort when cold air blows directly onto the horse. Although it is important to have fresh air constantly entering the horse barn throughout the year, it must be distributed evenly to minimize sudden temperature changes and drafts.

WHAT IS THE PURPOSE OF GOOD VENTILATION?

The first purpose of a ventilation system is to replace warm, moist, dusty and smelly air in the barn with the appropriate amount of fresh air. In winter, a ventilation rate of 12–19 L/sec (25–40 CFM, or cubic feet per minute) per horse housed is ideal. In summer, ventilation rates as high as 142 L/sec (300 CFM) per horse are needed to keep barn air temperatures from rising.

The second purpose of a ventilation system is to ensure good air distribution throughout the barn so that it can replace the warm, moist, dusty, smelly air with fresh air to avoid any "dead air pockets" in the space (Figure 1).

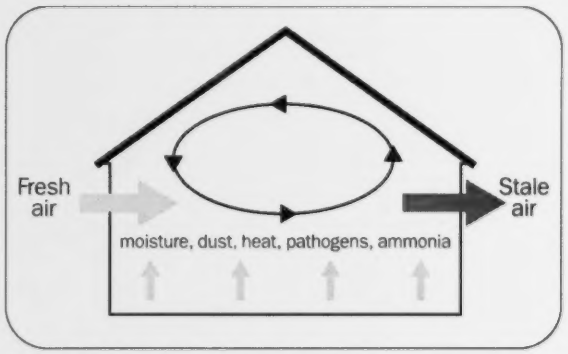

Figure 1. A good air distribution system removes excess heat and moisture, while minimizing air contaminants and drafts.

Ministry of Agriculture, Food and Rural Affairs

Ontario

HOW DOES A VENTILATION SYSTEM WORK?

Air has two very important properties that need to be understood before you can properly design and operate a barn ventilation system.

Moisture-Holding Capacity

Air has the capacity to hold moisture in water vapor form. The amount of moisture held by a fixed volume of air (relative humidity, or RH) increases as the temperature of that air rises. For example, cold outside air has very little moisture-holding capacity, whereas warm air has a significantly higher moisture-holding capacity. For every 10°C increase in air temperature, moisture-holding capacity of the air doubles (approximately). This unique feature of air allows a ventilation designer to heat the incoming outside fresh air so that it can wick or "sponge up" the respired moisture from the horses. If little or no heating is provided, as in a natural ventilation system, a large volume of air must be exchanged to remove excess moisture produced by the horses and general activities. However, if heat is added, only a small quantity of fresh air is needed to remove the moisture.

Thermal Buoyancy of Air

Buoyancy is the tendency of warm air to rise. Warm air is less dense than cold air, so it is lighter. This principle works well in natural ventilation systems where the warmer barn air, caused by horse body heat, is allowed to rise up and exhaust in a peak vent or chimney, carrying the respired moisture and active gases with it. The greater the temperature difference between inside the barn and outside the barn, the larger the uplift or buoyancy force to exhaust this foul air. When a fresh air inlet is not well designed, the cold incoming replacement air falls to the floor and creates significant drafts during the fall-winter-spring time period. Buoyancy is not effective in warm weather since there is very little temperature difference between inside and outside. For these conditions, natural ventilation relies on summer breezes to remove moisture, heat, odours and active gases.

NATURAL VENTILATION SYSTEM

A natural ventilation system uses air buoyancy and wind effects to move air (Figure 2). Natural ventilation systems are quieter than fan systems and provide more daylight, but require more management to maintain uniform temperatures and air quality inside the horse barn.

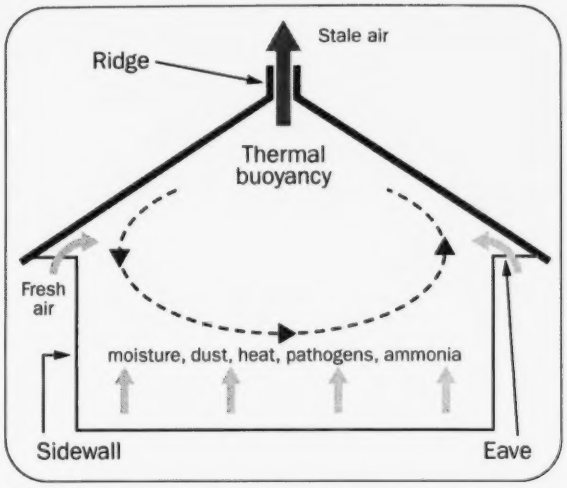

Figure 2. Natural ventilation systems rely on the thermal buoyancy properties of air to remove heat, moisture and air contaminants from the barn during colder months.

The key consideration for a natural ventilation system is building orientation. The length of the building must be perpendicular to the prevailing wind. Obstructions around the barn prevent fresh air movement, especially when they are located within a distance 10 times the height of the ridge peak of the horse barn. If obstructions cannot be removed, use mechanical ventilation.

Another challenge with natural ventilation systems is condensation on building surfaces. When the warm, moist air rises to be evacuated out of the barn, it comes in contact with the cold surfaces of the roof, creating condensation. Water droplets dripping from the roof can deteriorate building components and is uncomfortable for horses and workers.

Naturally ventilated barns must be appropriately designed in terms of animal density and height of the roof to permit thermal buoyancy to occur (Table 1).

Table 1. Natural ventilation openings

	Building Width		
	10 m	**20 m**	**30 m**
Side wall opening (mm)	300	600	900
Eave slot opening (mm)	75	100	150
Ridge slot opening (mm)	150	200	300

COLD BARNS, NATURALLY VENTILATED

Cold barns are unheated housing, often with an open front sidewall or end. They require considerable management to adjust the ventilation openings to prevent drafts and condensation. Often, these barns are not insulated or have minimal insulation to prevent condensation. Their main challenge is to achieve sufficient fresh air flow to control moisture without creating cold air drafts.

Cold barns have:

- an open ridge that is never closed to allow slightly warmer, moist air to rise and escape
- a small eave opening to introduce fresh air at the top of the side wall, well away from the animals, to reduce draft potential and maximize air distribution
- large ventilation doors along both side walls for additional air movement that can be tilt-in wall panels, adjustable curtains or sliding panels, which will be controlled either manually or automatically, based on weather conditions

To prevent condensation problems, it is important that the underside of the roof steel is covered with a minimum RSI 0.7 (R-4) insulation as a drip barrier. Many barns will have the side walls lined with minimal insulation to further reduce condensation and provide a slightly warmer environment. A building contractor can help select and install proper insulation to reduce condensation and moisture accumulation.

WARM BARNS, NATURALLY VENTILATED

Many horse barns are fully insulated to provide a more comfortable environment both for the horses and staff. If no supplementary heat is added, a fully insulated barn can operate 5°C–10°C warmer than outside, but may reach the freezing point in winter weather. To prevent freezing, install a heating system rather than reducing or eliminating the ventilation.

The side-wall vent openings are similar to those used for cold, natural ventilation systems with the addition of insulated panels or double-glazed window-type vents. Rather than a continuous peak vent, these barns are equipped with one or more chimneys for exhaust. If the barn has an attic or overhead feed storage loft, insulate the chimney to at least RSI 1.8 (R-10), extend it completely through the attic or loft and exit it through the peak as an enclosed shaft. This prevents condensation problems as well as subsequent deterioration of feed quality and building structure.

The chimneys shown in Figure 2 are 600 mm x 600 mm (2 ft x 2 ft) in one-storey barns and 1,200 mm x 1,200 mm (4 ft x 4 ft), for practical reasons, in two-storey barns. Provide a total exhaust air-shaft capacity of 0.5%–1.0% of the barn floor area. A control damper with 90% closing capability located near the top of the chimney will keep the chimney charged with warm air, preventing cold down drafts. The damper is usually controlled manually by cable.

For summer stabling of horses inside, considerably more side-wall opening (5%–10% of the barn floor area) is required to allow fresh air in the form of summer breezes in one side or end and exhaust it out the other end. Doors and windows provide the additional air openings needed, but still must be managed to prevent drafts at night or during storms.

FAN-VENTILATED BARN

In fan-ventilated barns, the air exchange and distribution is done mechanically. Fully insulate the barn to at least RSI 3.5 (R-20). Since every fan places a small vacuum on the room, all openings into the structure (including cracks around windows and doors) become jets of air and are likely to be drafts. For this reason, it is important that a properly designed air inlet is provided and that the incoming air is heated as quickly as possible to remove its draft potential and enhance its moisture-holding capacity before reaching the horses and/or the exhaust fans. In other words, make the incoming air do some work for you before exhausting it out to the atmosphere.

Exhaust Fans

The range of ventilation required per horse is from 25 CFM in winter to 300 CFM during warm weather. Unless there are more than 15 horses in the stable, select the smallest commercially available fan (approximately 300 CFM) as the base ventilation rate and provide sufficient supplemental heat to maintain this level of continuous air exchange during winter. This higher rate is necessary since air quality is a function of the rate of air exchange rather than horse population.

Ideally, ventilation designers like to provide at least two air changes per hour to guarantee good-quality air. However, many barns are limited to one air change per hour to minimize heating costs. At typical horse-barn stocking densities, a winter ventilation rate of 40 CFM per horse (double the minimum) is one air change per hour.

Since it is important to provide a reasonable progression of ventilation stages or steps between the winter minimum and the summer maximum, the use of at least two exhaust fans with a two-speed or variable-speed feature is necessary. A good choice for barns housing less than 15 horses is a pair of variable speed fans each with a capacity of 142 L/sec to 472 L/sec (300–1,000 CFM). Control these fans automatically with a temperature sensor to maintain the desired barn temperature. A ventilation equipment supplier can assist with sizing and proper installation of the exhaust fans.

Air Inlets

Air inlets are slot-type openings through the top of the side wall from outside or through the ceiling from a fresh-air attic space or duct. Several companies offer this style of inlet as pre-manufactured units. It is possible to use windows as the air inlet if they are well managed. The problem with using windows is how frequently they have to be adjusted as the temperature or wind changes and their tendency to create drafty conditions for horses in adjacent stalls. Provide 0.2 m^2 (2 ft^2) of intake opening for every 472 L/sec (1,000 CFM) of air exchange required.

Some existing two-storey barns are already quite "leaky" and easily provide the fresh air capacity required for fall-winter-spring ventilation without installing specific air inlets. The challenge with these barns is preventing drafts from this air infiltration. An internal air duct system can mix sufficient barn air with this infiltration air to create a blended air mix that eliminates the draft problem.

Some horse barns use an air duct ventilation system to help achieve uniform distribution of fresh air throughout the entire barn (Figure 3). With this system and a tight barn, the fresh air is allowed in one end of the barn through motorized shutters or other openings, mixed with some barn air and distributed along the length of the barn through an air duct with holes spaced along one or both sides of the duct. These ducts are constructed with plywood or plastic board materials. Some of these ducts are insulated to further reduce condensation, but this should not be necessary if the air mix is warm enough. Ideally, these ducts have a hinged bottom to allow periodic clean-out of dust and dirt. Some companies have tried dust filters on the ducts but daily cleaning makes them impractical. An added advantage of a duct system is that it uniformly distributes supplemental heat throughout the barn.

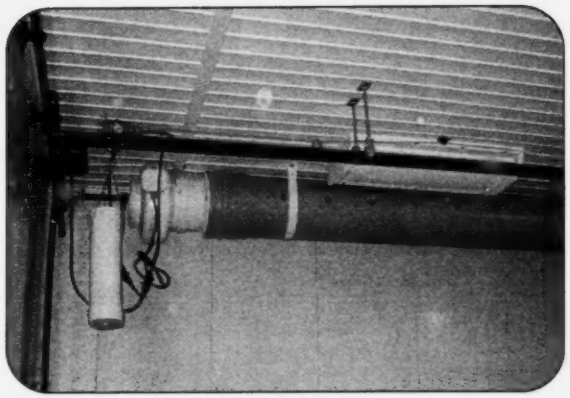

Figure 3. Air circulation assist using a rigid duct with fan and air distribution holes.

Supplemental Heat

If the horse barn is to be kept above freezing, supplemental heat is required. There are not enough horses in the barn to produce enough heat to keep the barn warm enough while still maintaining a minimum amount of at least one barn air exchange per hour. Ensure the barn is adequately insulated and sealed (except for air inlets) and the desired operating temperature established to determine the amount of heating required. The higher the desired temperature, the higher the cost of operating the facility. Sale and show barns are often heated to discourage winter hair coat growth or to encourage the shedding of hair. For most horse barns, an operating temperature of 10°C is quite common and minimizes heating costs. Calculate specific heating requirements for each stable, but a guideline for a reasonably well-insulated barn with normal ventilation rate is 500–1,000 watts per horse (1,700–3,400 BTU/hr/horse). Sometimes, a forced-air electric unit heater is used for this purpose but the more economical propane-fired or natural gas unit heaters are gaining popularity. Other choices include a conventional forced-air furnace or a hot water boiler system located in a separate room. Consult your ventilation and heating supplier for design assistance and proper maintenance of your furnace.

Ventilation Controls and Monitoring

Most ventilation suppliers offer an electronic controller that interlocks the ventilating fans and the heating system. This ensures the heating system is off before the ventilation rate is increased so that heating operates with minimum ventilation. This type of control is essential to limit heating costs. Locate the controller out of easy reach to prevent unauthorized changes to the desired settings.

Use basic monitoring tools to check the barn environment. A minimum-maximum thermometer shows the temperature fluctuation that the stable experiences. The humidity level can be monitored with a sling psychrometer or an electronic hygrometer. Smoke pencils are used to check air movement and the potential for drafts in the stable area. Various gas levels, such as ammonia and carbon dioxide, are measured with gas detection tubes. These devices are available through scientific or safety supply companies.

ADDITIONAL INFORMATION

OMAFRA's *Ventilation for Livestock and Poultry Facilities*, Publication 833, is a great reference for details on the design and installation of ventilation systems for agricultural operations. It offers good examples on design and calculations. Farm building contractors, ventilation suppliers and engineering consultants can provide technical assistance concerning ventilation system design and installation. Be sure to include ventilation when planning your horse stable to minimize respiratory health problems and maintain good air quality for your horses and workers.

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